ditioned by these. With this assumption the decrease of the motion is thus explained by Dr. Puluj, according to the kinetic theory of gas: With full atmospheric pressure the reaction-force aroused on the vanes is too small to overcome the resistance of friction and the air. With sufficient rarefaction it overcomes these resistances, and the motion begins. If the reaction-force, like the internal friction, decreases but very slowly with the pressure, the velocity of motion reaches, at a certain pressure, the maximum, and on further rarefaction it decreases, because not only the resistance of the air, but also the reaction-force awakened becomes smaller with the smaller number of rebounding molecules. In an absolutely vacuous space, the motion must quite cease, if no emission of particles took place from the vanes. Dr. Puluj further describes a radiometer, consisting of a fixed cross with mica vanes blackened on one side, and a very thin cylindrical glass cover. The outer vane edges were 2 mm. distant from the glass. The glass cylinder turned, on illumination, in an opposite direction to that in which the cross should turn. The object of the experiment was to prove that the movements of the radiometer could also not be explained by air currents.

PROF. KLINKERFUES, the director of the Göttingen Observatory, has taken out a patent for a new invention in telegraphy. The professor has discovered a method by which up to eight different messages may be sent simultaneously by the same wire, an apparatus at the receiving end printing the messages separately and all at the same time. The importance of this invention to telegraphy generally needs no comment.

AT Cannstatt (near Stuttgart) a horticultural exhibition will be held from the 25th till the 29th inst.

A NEW periodical devoted to aëronautics will be published at St. Petersburg from January next, under the name of *The Aëronaut* (*Vozdukhoplavatel*). Its editor will be M. Klinder.

A SHOCK of earthquake was felt at Lyons on the 9th inst. at 7 A.M. It proceeded in a south-northerly direction and lasted two seconds.

DR. KING'S annual report on the Cinchona Plantations in British Sikkim for the year ending March 31 last, together with that of the Government quinologist, Mr. C. H. Wood, are extremely satisfactory, both with regard to the cultivation and extension of the most valuable species of cinchona as well as in the preparation of the cinchona febrifuge. Of red bark trees, *Cinchona succirubra*, 353,415 were planted out, namely, 24,725 to replace old plants uprooted in taking the bark crop, and 328,690 on new land. Special attention has been paid to the most valuable of all the medicinal barks, *C. calisaya*, known as the yellow bark tree. Of this kind there were in the nursery beds at the close of the year 60,000 cuttings and seedlings in the Mungpoo division and 1,000 in the Sittong division, all of which were nearly ready at the time the report was written, for transfer to the permanent plantations. The first crop of bark of this species was obtained in the Sikkim plantation during the past season, the result showing a yield of about 1,400 lbs. of dry bark. This species we are, however, informed, is very capricious in growth, and no locality with perfectly suitable climatic conditions for it has yet been found in British Sikkim. For the purpose of ascertaining correctly the conditions under which the Dutch have succeeded in growing the tree cheaply in Java, Dr. King has received authority to proceed thither. The summary of all kinds of cinchona plants planted out during the year under review shows a total of 4,028,055, of which 3,589,965 were of the red bark species. As nearly 300,000 lbs. of bark, the produce of the previous year, remained in the quinologist's hands, it was not deemed advisable to collect a larger crop than was really necessary to meet the requirements of the febrifuge factory, consequently the total crop of bark taken amounted to only 261,659 lbs. The continuous increase in the amount of febrifuge manufactured by the Government quinologist is very marked, for while in the year 1874-75 only 48 lbs. were produced, which in the following year had increased to 1,940 lbs., in the year under review no less a quantity than 7,007 lbs. were turned out, but notwithstanding this rapid development of the manufacture the increasing confidence in the efficacy of the febrifuge has raised the demand for it so much that the consumption of the past year greatly exceeded the quantity manufactured. To meet this growing demand the scale of manufacture at Mungpoo has been extended. Whether the febrifuge now so largely manufactured in India is capable of being improved by eliminating any of its constituents is a question still under the consideration of the committee appointed in 1877. It is satisfactory, however, to find that the further experience in the use of the drug during the past year has increased the confidence of the public and of the medical profession in its virtues. The question of manufacturing a superior drug which would not be exposed to the prejudices which have so long delayed the free distribution of the present febrifuge is still under the consideration of the committee before referred to. It is stated that it will probably be found advisable to manufacture at a slightly increased cost a preparation composed of the three sulphates, cinchonidine, cinchonine, and quinine in conjunction.

THE Congress of Viticulturists which took place at Coblenz on the 4th inst. will meet at Heilbronn next year, and the apicultural meeting which was held at Prague on the 7th inst. selected Cologne as a meeting place for 1880.

THE additions to the Zoological Society's Gardens during the past week include two African Sheep (*Ovis aries*) from West Africa, presented by Mr. R. B. N. Walker, C.M.Z.S.; two Ring-tailed Coatis (*Nasua rufa*) from South America, presented respectively by Mr. Chas. S. Barnes and Mr. Percy Brewis; a Common Fox (*Canis vulpes*), British, presented by Mr. Jas. Wheatley; a Caracal (*Felis caracal*), a Secretary Vulture (*Serpentarius reptilivorus*) from South Africa, presented by Dr. Holub; two Dunlins (*Tringa cinclus*), a Turnstone (*Strepsilas interpres*), a Ringed Plover (*Œgialitis hiaticula*), British, presented by Mr. Edmund A. T. Elliot; two Common Cuckoos (*Cuculus canorus*), British, presented respectively by Mrs. Bolton and Miss C. Bealey; a Turquoisine Parrakeet (*Euphema pulchella*) from New South Wales, presented by Mr. J. Fraser; a Square-spotted Snake (*Oxyrrhopus doliatus*) from South America, presented by Mr. H. Colgate; a Chacma Baboon (*Cynocephalus porcarius*), a Yellow Baboon (*Cynocephalus babouin*), an Isabelline Antelope (*Cervicapra isabellina*), a Sociable Vulture (*Vultur auricularis*), two Tawny Eagles (*Aquila nœvioides*), two Cape-crowned Cranes (*Balearic regulorum*), a Stanley Crane (*Tetrapteryx paradisea*), from South America, deposited.

HISTORY AND METHODS OF PALÆONTOLOGICAL DISCOVERY[1]

II.

WHILE the Paris Basin was yielding such important results for palæontology, its geological structure was being worked out with great care. The results appeared in a volume by Cuvier and Alex. Brongniart, chiefly the work of the latter, published in 1808.[2] This was the first systematic investigation of tertiary strata. Three years later, the work was issued in a more extended form. The separate formations were here carefully distinguished by their fossils, the true importance of which for this purpose being distinctly recognized. This advance was not accepted without some opposition, and it is an

[1] An Address, delivered before the American Association for the Advancement of Science, at Saratoga, N.Y., August 28, 1879, by Prof. O. C. Marsh, President. Continued from p. 499.

[2] "Essai sur la Géographie minéralogique des Environs de Paris." 4to., 1808.

interesting fact that Jameson, who claimed for Werner the theory here put in practice, rejected its application, and wrote as follows: "To Cuvier and Brongniart we are indebted for much valuable information in their description of the country around Paris, but we must protest against the use they have made of fossil organic remains in their geognostical descriptions and investigations."[1]

William Smith (1769-1839), "the father of English geology," had previously published a "Tabular View of the British Strata." He appears to have arrived independently at essentially the same view as Werner in regard to the relative position of stratified rocks. He had determined that the order of succession was constant, and that the different formations might be identified at distant points by the fossils they contained. In his later works, "Strata identified by Organised Fossils," published in 1816-20, and "Stratigraphical System of Organised Fossils," 1817, he gave to the world results of many years of careful investigations on the secondary formations of England. In the latter work he speaks of the success of his method in determining strata by their fossils, as follows: "My original method of tracing the strata by the organised fossils imbedded therein, is thus reduced to a science not difficult to learn. Ever since the first written account of this discovery was circulated in 1799, it has been closely investigated by my scientific acquaintances in the vicinity of Bath, some of whom search the quarries of different strata in that district, with as much certainty of finding the characteristic fossils of the respective rocks, as if they were on the shelves of their cabinets."

The systematic study of fossils now attracted attention in England, also, and was prosecuted with considerable zeal, although with less important results than in France. An extensive work on this subject, by James Parkinson, entitled "Organic Remains of a Former World," was begun in 1804, and completed in three volumes in 1811. A second edition appeared in 1833. This work was far in advance of previous publications in England, and, being well illustrated, did much to make the collection and study of fossils popular. The belief in the geological effects of the deluge had not yet lost its power, although restricted now to the later deposits; for Parkinson in his later edition, wrote as follows: "Why the earth was at first so constituted that the deluge should be rendered necessary—why the earth could not have been at first stored with all those substances, and endued with all those properties which seem to have proceeded from the deluge—why so many beings were created, as it appears, for the purpose of being destroyed—are questions which I presume not to answer."

William Buckland (1784-1856), published in 1823 his celebrated "Reliquiæ Diluvianæ," in which he gave the results of his own observations in regard to the animal remains found in the caves, fissures, and alluvial gravels of England. The facts presented are of great value, and the work was long a model for similar researches. Buckland's conclusions were, that none of the human remains discovered in the caves were as old as the extinct mammals found with them, and that the deluge was universal. In speaking of fossil bones found in the Himalayan Mountains, he says: "The occurrence of these bones at such an enormous elevation in the region of eternal snow, and consequently in a spot now unfrequented by such animals as the horse and deer, can, I think, be explained only by supposing them to be of antediluvian origin, and that the carcases of the animals were drifted to their present place, and lodged in sand, by the diluvial waters.

The foundation of the "Geological Society of London," in 1807, marks an important point in the history of palæontology. To carefully collect materials for future generalisations, was the object in view, and this organisation gradually became the centre in Great Britain for those interested in geological science. The society was incorporated in 1826, and has since been the leading organisation in Europe for the advancement of the sciences within its field. The Geological Society of France, established at Paris in 1832, and the German Geological Society, founded at Berlin in 1848, have likewise contributed largely to geological investigations in these countries, and to some extent in other parts of the world. In the publications of these three societies the student of palæontology will find a mine of valuable materials for his work.[2]

The systematic study of fossil plants may be said to date from the publication of Adolphe Brongniart's "Prodrome," in 1828.[3]

[1] Translation of Cuvier's Discourse. Note K. (B.), p, 103, 1817.
[2] "Recherches sur les Poissons fossiles," 1833-45.
[3] "Prodrome d'une Histoire des Végétaux fossiles." 8vo. Paris, 1828.

This was very soon followed by his larger work, "Histoire des Végétaux fossiles," issued in 1828-48. Brongniart pursued the same method as Cuvier and Lamarck, viz.: the comparison of fossils with living forms, and his results were of great importance. In his "Tableau des Genres Végétaux fossiles," &c., published in Paris in 1849, he gives the classification and distribution of the genera of fossil plants, and traces out the historical progression of vegetable life on the globe, as he had done to a great extent in his previous works. He shows that the cryptogamic forms prevailed in the primary formations; the conifers and cycads in the secondary, and the higher forms in the tertiary, while four-fifths of living plants are exogens.

In England Lindley and Hutton published, in 1831-37, a valuable work in three volumes, entitled, "Fossil Flora of Great Britain." This work was illustrated by many accurate plates, in which the plants of the coal formation were especially represented. Henry Witham also published two works in 1831 and 1833, in which he treated especially of the internal structure of fossil plants. "Antediluvian Phytology," by Artis, was published in London in 1838. Bowerbank's "History of the Fossil Fruits and Seeds of the London Clay" appeared in 1843. Hooker's memoir "On the Vegetation of the Carboniferous Period, as compared with that of the Present Day," published in 1848, was an important contribution to the science. Bunbury, Williamson, and others, also published various papers on fossil plants. This branch of palæontology, however, attracted much less attention in England than on the Continent.

In Germany the study of fossil plants dates back to the beginning of the century. Von Schlotheim, a pupil of Werner, published in 1804 an illustrated volume on this subject. A more important work was that of Count Sternberg, issued in 1820-38, and illustrated with excellent plates. Cotta, in 1832, published a book with the title, "Die Dendrolithen," in which he gave the results of his investigations on the inner structure of fossil plants. Von Gutbier, in 1835, and Germar in 1844-53, described and figured the plants of two important localities in Germany. Corda's "Beiträge zur Flora der Vorwelt," issued at Prague in 1845, was essentially a continuation of the work of Sternberg. Unger's "Chloris protogæa," 1841-45, "Genera et Species Plantarum Fossilium," 1850, and his larger work, published in 1852, are all standard authorities. In the latter the theory of descent is applied to the vegetable world. Schimper and Mougeot's "Monograph on the Fossil Plants of the Vosges," 1845, was well illustrated, and contained noteworthy results.

Göppert, in 1836, published a valuable memoir entitled "Systema Filicum Fossilium," in which he made known the results of his study of fossil ferns. In the same year this botanist began a series of experiments, in which he attempted to imitate the process of fossilisation, as found in nature. He steeped various animal and vegetable substances in waters holding, some calcareous, others siliceous, and others metallic matter in solution. After a slow saturation the substances were dried and exposed to heat until the organic matters were burned. In this way Göppert successfully imitated various processes of petrifaction, and explained many things in regard to fossils that had previously been in question. His discovery of the remains of plants throughout the interior of coal did much to clear up the doubts about the formation of that substance. In 1841 Göppert published an important work, in which he compared the genera of fossil plants with those now living. In 1852, another extensive work by this author appeared, entitled "Fossile Flora des Uebergangs-Gebirges."

Andræ, Braun, Dunker, Ettingshausen, Geinitz, and Goldenberg, all made notable contributions to fossil botany in Germany, during the period we are now considering.

The systematic study of invertebrate fossils, so admirably begun by Lamarck, was continued actively in France. The tertiary shells of the Seine Valley were further investigated by Defrance, and especially by Deshayes, whose great work on this subject was begun in 1824.[1] Des Moulin's essay on "Sphérulites" in 1826, Blainville's memoir on "Belemnites" in 1827, Férussac's various memoirs on land and fresh water fossil shells, were valuable additions to the subject. A later work of great importance was D'Orbigny's "Paléontologie française," 1840-44, which described the mollusca and radiates in detail, according to formations. The other publications of this author are both numerous and valuable. Brongniart and

[1] "Description des Coquilles fossiles des Environs de Paris." 3 vols. Paris, 1824-37.

Desmarest's "Histoire naturelle des Crustaces fossiles," published in 1822, is a pioneer work on this subject. Michelins' memoir on the fossil corals of France, 1841-46, was another important contribution to palæontology. Agassiz's works on fossil echinoderms and molluscs are valuable contributions to the science. The works of d'Archiac, Coquand, Cotteau, Desor, Edwards, Haime, and de Verneuil, are likewise of permanent value.

In Italy, Bellardi, Merian, Michellotti, Phillipi, Zigno, and others, contributed important results to palæontology.

In Belgium, Bosquet, Nyst, Koninck, Ryckholt, van Beneden, and others, have all aided materially in the progress of the science.

In England, also, invertebrate fossils were studied with care, and continued progress was made. Sowerby's "Mineral Conchology of Great Britain," in six volumes, a systematic work of great value, was published in 1812-30, and soon after was translated into French and German. Its figures of fossil shells are excellent, and it is still a standard work. Miller's "Natural History of the Crinoidea," published at Bristol, in 1821, and Austin's later monograph, are valuable for reference. Brown's "Fossil Conchology of Britain and Ireland" appeared in 1839, and Brodie's "History of the Fossil Insects of England" in 1845. Phillips' illustration of the geology of Yorkshire, 1829-36, and his work on the "Palæozoic Fossils of Cornwall, Devonshire, and West Somerset," 1843, contained a great deal of original matter in regard to fossil remains. Morris's "Catalogue of British Fossils," issued in 1843, and the later edition in 1854, is most useful to the working palæontologist. The memoirs of Davidson on the Brachiopoda, Edwards, Forbes, Morris, Lycett, Sharpe, and Wood, on other Mollusca, Wright on the Echinoderms, Salter on Crustacea, Busk on Polyzoa, Jones on the Entomostraca, and Duncan and Lonsdale on Corals, are of especial value. King's volume on Permian Fossils, Mantel's various memoirs, Dixon's work on the Fossils of Sussex, 1850, and McCoy's works on Palæozoic Fossils all deserve honourable mention. Sedgwick, Murchison, and Lyell, although their greatest services were in systematic geology, each contributed important results to the kindred science of palæontology during the period we are reviewing.

In Germany, Schlotheim's treatise, "Die Petrifactenkunde," published at Gotha in 1820, did much to promote a general interest in fossils. By far the most important work issued on this subject was the "Petrifacta Germanica," by Goldfuss, in three folio volumes, 1826 to 1844, which has lost little of its value. Bronn's "Geschichte der Natur," 1841-46, was a work of great labour, and one of the most useful in the literature of this period. The author gave a list of all the known fossil species, with full reference, and also their distribution through the various formations. This gave exact data on which to base generalisations, hitherto of comparatively little value.

Among other early works of interest in this department may be mentioned Dalman's memoir on "Trilobites," 1828, and Burmeister's on the same subject, 1843. Giebel's well-known "Fauna der Vorwelt," 1847-1856, gave lists of all the fossils described up to that time, and hence is a very useful work. The "Lethæa Geognostica" by Bronn, 1834-38, and the second edition by Bronn and Roemer, 1846-56, is a comprehensive general treatise on palæontology, and the most valuable work of the kind yet published.

The researches of Ehrenberg, in regard to the lowest forms of animals and plants, threw much light on various points in palæontology, and showed the origin of extensive deposits, the nature of which had before been in doubt. Von Buch, Barrande, Beyrich, Berendt, Dunker, Geinitz, Heer, Hörnes, Klipstein, von Münster, Reuss, Roemer, Sandberger, Suess, von Hagenow, von Hauer, Zeiten, and many others, all aided in the advancement of this branch of science. Angelin, Hisinger, and Nilsson, in Scandinavia; Abich, De Waldheim, Eichwald, Keyserling, Kutorga, Nordman, Pander, Rouillier, and Volborth, in Russia; and Pusch in Poland, published important results on fossil invertebrates.

The impetus given by Cuvier to the study of vertebrate fossils extended over Europe, and great efforts were made to continue discoveries in the direction he had so admirably pointed out.

Louis Agassiz (1807-73), a pupil of Cuvier, and long an honoured member of this association, attained eminence in the study of ancient as well as of recent life. His great work on Fossil Fishes[1] deserves to rank next to Cuvier's "Ossemens fossiles." The latter contained mainly fossil mammals and reptiles, while the fishes were left without a historian till Agassiz began his investigations. His studies had admirably fitted him for the task, and his industry brought together a vast array of facts bearing on the subject. The value of this grand work consists not only in its faithful descriptions and plates, but also in the more profound results it contained. Agassiz first showed that there is a correspondence between the succession of fishes in the rocks, and their embryonal development. This is now thought to be one of the strongest points in favour of evolution, although its author interpreted the facts as bearing the other way.

Pander's memoirs on the fossil fishes of Russia form a worthy supplement to Agassiz's classic work. Brandt's publications are likewise of great value; and those of Lund, in Sweden, have an especial interest to Americans, in consequence of his researches in the caves of Brazil.

Croizet and Jobert's "Recherches sur les Ossemens fossiles du Département du Puy-de-Dôme," published in 1828, contained valuable results in regard to fossil mammals. Geoffroy St. Hilaire's researches on fossil reptiles, published in 1831, were an important advance. De Serres and De Christol's explorations in the caverns in the south of France, published between 1829 and 1839, were of much value. Schmerling's researches in the caverns of Belgium, published in 1833-36, were especially important on account of the discovery of human remains mingled with those of extinct animals. Deslongchamp's memoirs on fossil reptiles, 1835, are still of great interest. Pictet's general treatise on palæontology was a valuable addition to the literature, and has done much to encourage the study of fossils.[2] De Blainville, in his grand work, "Ostéographie," issued in 1839-56, brought together the remains of living and extinct vertebrates, forming a series of the greatest value for study. Aymard and Pomel's contributions to vertebrate palæontology are both of value. Gervais and Lartet added much to our knowledge of the subject, and Bravard and Hébert's memoirs are well known.

The brilliant discoveries of Cuvier in the Paris Basin excited great interest in England, and when it was found that the same tertiary strata existed in the south of England, careful search was made for vertebrate fossils. Remains of some of the same genera described by Cuvier were soon discovered, and other extinct animals new to science were found in various parts of the kingdom. König, to whom we owe the name *Ichthyosaurus*, and Conybeare, who gave the generic designation *Pleisosaurus*, and also *Mososaurus*, were among the earliest writers in England on fossil reptiles. The discovery of these three extinct types, and the discussion as to their nature, forms a most interesting chapter in the annals of palæontology. The discovery of the *Iguanodon*, by Mantell, and the *Megalosaurus*, by Buckland, excited still higher interest. These great reptiles differed much more widely from living forms than the mammals described by Cuvier, and the period in which they lived soon became known as the "age of reptiles." The subsequent researches of these authors added largely to the existing knowledge of various extinct forms, and their writings did much to arouse public interest in the subject.

Richard Owen, a pupil of Cuvier, followed, and brought to bear upon the subject an extensive knowledge of comparative anatomy, and a wide acquaintance with existing forms. His contributions have enriched almost every department of palæontology, and of extinct vertebrates especially he has been, since Cuvier, the chief historian. The fossil reptiles of England he has systematically described, as well as those of South Africa. The extinct struthious birds of New Zealand he has made known to science, and accurately described in extended memoirs. His researches on the fossil mammals of Great Britain, the extinct Edentates of South America, and the ancient Marsupials of Australia, each forms an important chapter in the history of our science.

The personal researches of Falconer and Cautley in the Sivalik Hills of India brought to light a marvellous vertebrate fauna of pliocene age. The remains thus secured were made known in their great work "Fauna Antiqua Sivalensis," published in London in 1845. The important contributions of Egerton to our knowledge of fossil fishes and Jardine's well-known work, "Ichnology of Annandale," also belong to this period.

The study of vertebrate fossils in Germany was prosecuted

[1] "Recherches sur les Poissons fossiles," 1833-45.

[2] "Traité élémentaire de Paléontologie," etc., Genève. 4 vols. 1844-46. Second Edition. Paris, 1853-55.

with much success during the present period. Blumenbach, the ethnologist, in several publications between 1803 and 1814, recorded valuable observations on this subject. In 1812 Sömmerring gave an excellent figure of a pterodactyle, which he named and described. Goldfuss's researches on the fossil vertebrates from the caves of Germany, published in 1820-23, made known the more important facts of that interesting fauna. His later publications on extinct amphibians and reptiles were also noteworthy. Jäger's investigations on the extinct vertebrate fauna of Würtemberg, published between 1824 and 1839, were an important advance. To Plieninger's researches in the same region, 1834-44, we owe the discovery of the first triassic mammal (*Microlestes*), as well as important information in regard to labyrinthodonts. Kaup's researches on fossil mammals, 1832-41, brought to light many interesting forms, and to him we are indebted for the generic name *Dinotherium*, and excellent descriptions of the remains then known.

Count Münster's "Beiträge zur Petrifactenkunde," published 1843-46, contained several valuable papers on fossil vertebrates, and the separate papers by the same author are of interest. Andreas Wagner wrote on Pterosaurians in 1837, and later gave the first description of fossil mammals of the tertiary of Greece, 1837-40. Johannes Müller published an important illustrated work on the zeuglodonts, in 1849, and various notable memoirs, and Quenstedt, interesting descriptions of fossil reptiles, as well as other papers of value. Rütimeyer's suggestive memoirs are widely known.

Hermann von Meyer's contributions to vertebrate palæontology are by far the most important published in Germany during the period we are now considering. From 1830, his investigations on this subject were continuous for nearly forty years, and his various publications are all of value. His "Beiträge zur Petrifactenkunde," 1831-33, contains a series of valuable memoirs. His "Palæologica," issued in 1832, includes a synopsis of the fossil vertebrates then known, with much original matter. His great work, "Zur Fauna der Vorwelt," 1845-60, includes a series of monographs invaluable to the student of vertebrate palæontology. This work, as well as his other chief publications, was illustrated with admirable plates from his own drawings. Other memoirs by this author will be found in the "Palæontographica," of which he was one of the editors. In the many volumes of this publication, which began in 1851, and is still continued, will be found much to interest the investigator in any branch of palæontology.

The Palæontographical Society of London, established in 1847, has also issued a series of volumes containing valuable memoirs in various branches of palæontology. These two publications together are a storehouse of knowledge in regard to extinct forms of animal and vegetable life.

It may be interesting here to note briefly the use of general terms in palæontology, as the gradual progress of the science was indicated to some extent in its terminology. At first, and for a long time, the name *fossil* was appropriately used for objects dug from the earth, both minerals and organic remains. The term "Oryctology," having essentially the same meaning, was also used for this branch of study. For a long period, too, the termination *ites* (λίθος, a stone) was applied to fossils to distinguish them from the corresponding living forms; as, for instance, *Ostracites*, used by Pliny. At a later date, the general name "figured stones" (*Lapides figurati*) was extensively used; and less frequently, "deluge stones" (*Lapides diluviani*). The term "organised fossils" was used to distinguish fossils from minerals, when the real difference became known, although the name *Reliquiæ* was sometimes employed. The term "petrifactions" (*Petrificata*) was defined by John Gesner in his work on fossils in 1758, and was afterwards extensively used. Palæontology is comparatively a modern term, having come into use only within the last half century. It was introduced about 1830, and soon was generally adopted in France and England; but in Germany it met with less favour, though used to some extent.

It would be interesting, too, did time permit, to trace the various opinions and superstitions, held at different times, in regard to some of the more common fossils, for example, the ammonite, or the belemnite. Of their supposed celestial origin; of their use as medicine by the ancients, and in the East to-day; of their marvellous power as charms, among the Romans, and still among the American Indians. It would be instructive, also, to compare the various views expressed by students in science, concerning some of the stranger extinct forms, for instance, the nummulites, among protozoa; the rudistes, among molluscs; or the mosasaurus, among reptiles. Dissimilar as such views were, they indicate in many cases gropings after truth—natural steps in the increase of knowledge.

The third period in the history of palæontology, which, as I have said, began with Cuvier and Lamarck at the beginning of the present century, forms a natural epoch extending through six decades. The definite characteristics of this period, as stated, were dominant during all this time, and the progress of palæontology was commensurate with that of intelligence and culture.

For the first half of this period, the marvellous discoveries in the Paris Basin excited astonishment, and absorbed attention; but the real significance and value of the facts made known by Cuvier, Lamarck, and William Smith, were not appreciated. There was still a strong tendency to regard fossils merely as interesting objects of natural history, as in the previous period, and not as the key to profounder problems in the earth's history. Many prominent geologists were still endeavouring to identify formations in different countries by their mineral characters, rather than by the fossils imbedded in them. Such names as "old red sandstone," and "new red sandstone," were given in accordance with this opinion. Humboldt, for example, attempted to compare the formations of South America and Europe by their mineral features, and doubted the value of fossils for this purpose. In 1823 he wrote as follows: "Are we justified in concluding that all formations are characterised by particular species? that the fossil shells of the chalk, the Muschelkalk, the Jura limestone, and the Alpine limestones, are all different? I think this would be pushing the induction much too far."[1] Jameson still thought minerals more important than fossils for characterising formations; while Bakewell, later yet, defines palæontology as comprising "fossil zoology and fossil botany, a knowledge of which may appear to the student as having little connection with geology."

During the later half of the third period, greater progress was made, and before its close geology was thoroughly established as a science. Let us consider for a moment what had really been accomplished up to this time.

It had now been proved beyond question that portions at least of the earth's surface had been covered many times by the sea, with alternations of fresh water and of land; that the strata thus deposited were formed in succession, the lowest of the series being the oldest; that a distinct succession of animals and plants had inhabited the earth during the different geological periods; and that the order of succession found in one part of the earth was essentially the same in all. More than 30,000 new species of extinct animals and plants had now been described. It had been found, too, that from the oldest formations to the most recent, there had been an advance in the grade of life, both animal and vegetable, the oldest forms being among the simplest, and the higher forms successively making their appearance.

It had now become clearly evident, moreover, that the fossils from the older formations were all extinct species, and that only in the most recent deposits were there remains of forms still living. The equally important fact had been established, that in several groups of both animals and plants, the extinct forms were vastly more numerous than the living; while several orders of fossil animals had no representatives in modern times. Human remains had been found mingled with those of extinct animals, but the association was regarded as an accidental one by the authorities in science; and the very recent appearance of man on the earth was not seriously questioned. Another important conclusion reached, mainly through the labours of Lyell was, that the earth had not been subjected in the past to sudden and violent revolutions; but the changes wrought had been gradual, differing in no respect from those still in progress. Strangely enough, the corollary to this proposition, that life, too, had been continuous on the earth, formed at that date no part of the common stock of knowledge.

In the physical world, the great law of "correlation of forces" had been announced, and widely accepted; but in the organic world, the dogma of the miraculous creation of each separate species still held sway, almost as completely as when Linnæus declared: "There are as many different species as there were different forms created in the beginning by the

[1] "Essai géognistique sur le Gisement des Roches," p. 41.

Infinite Being." But the dawn of a new era was already breaking, and the third period of palæontology we may consider now at an end.

Just twenty years ago, science had reached a point when the belief in "special creations" was undermined by well-established facts, slowly accumulated. The time was ripe. Many naturalists were working at the problem, convinced that evolution was the key to the present and the past. But how had Nature brought this change about? While others pondered Darwin spoke the magic word—"Natural Selection," and a new epoch in science began.

The fourth period in the history of palæontology dates from this time, and is the period of to-day. One of the main characteristics of this epoch is the belief that *all life, living and extinct, has been evolved from simple forms.* Another prominent feature is the accepted fact of *the great antiquity of the human race.* These are quite sufficient to distinguish this period sharply from those that preceded it.

The publication of Charles Darwin's work on the "Origin of Species," November, 1859, at once aroused attention, and started a revolution which has already in the short space of two decades changed the whole course of scientific thought. The theory of "Natural Selection," or, as Spencer has happily termed it, the "Survival of the Fittest," had been worked out independently by Wallace, who justly shares the honour of the discovery. We have seen that the theory of evolution was proposed and advocated by Lamarck, but he was before his time. The anonymous author of the "Vestiges of Creation," which appeared in 1844, advocated a somewhat similar theory, which attracted much attention, but the belief that species were immutable was not sensibly affected until Darwin's work appeared.

The difference between Lamarck and Darwin is essentially this: Lamarck proposed the theory of evolution; Darwin changed this into a doctrine, which is now guiding the investigation in all departments of biology. Lamarck failed to realise the importance of time, and the inter-action of life on life. Darwin, by combining these influences with those also suggested by Lamarck, has shown *how* the existing forms on the earth may have been derived from those of the past.

This revolution has influenced palæontology as extensively as any other department of science, and hence the new period we are discussing. In the last epoch species were represented independently, by parallel lines; in the present period they are indicated by dependent, branching lines. The former was the analytic, the latter is the synthetic, period. To-day the animals and plants now living are believed to be genetically connected with those of the distant past, and the palæontologist no longer deems species of the first importance, but seeks for relationships and genealogies, connecting the distant past with the present. Working in this spirit, and with such a method, the advance during the last decade has been great, and is an earnest of what is yet to come.

The progress of palæontology in Great Britain during the present period has been great, and the general interest in the science much extended. The views of Darwin soon found acceptance here. Next to his discovery of "Natural Selection," Darwin was fortunate in having so able and bold an expounder as Huxley, who was one of the first to adopt his theory and give it a vigorous support. Huxley's masterly researches have been of great benefit to all departments of biology, and his contributions to palæontology are invaluable. Among the latter his original investigations on the relations of birds and reptiles are especially noteworthy. His various memoirs on extinct reptiles, amphibians, and fishes, belong to the permanent literature of the subject. The important researches of Owen on the fossil vertebrates have been continued to the present time. He has added largely to his previous publications on the British fossil reptiles, birds, and mammals, the extinct reptiles of South Africa, and the post-tertiary birds of New Zealand. His description of the *Archæopteryx*, near the beginning of the period was a most welcome contribution.

The investigations of Egerton on fossil fishes have likewise been continued with important results. Busk, Dawkins, Flower, and Sanford have made valuable contributions to the history of fossil mammals. Bell, Günther, Hulke, Lankester, Powrie, Miall, and Seely, have made notable additions to our knowledge of reptiles, amphibians, and fishes. Among invertebrates the crustacea have been especially studied by Jones, Salter, and Woodward. Davidson, Etheridge, Lycett, Morris, Phillips, Wood, and Wright have continued their researches on molluscs; Duncan, Nicholson, and others, have investigated the extinct corals, and Binney and Carruthers the fossil plants. Numerous other important contributions have been made in Great Britain to the science during the present period.

On the Continent the advance in palæontology has, during the last two decades, been equally great. In France Gervais continued his memoirs on extinct vertebrates nearly to the present date; while Gaudry has published several volumes on the subject that are models for all students of the science. His work on the fossil animals of Greece is a perfect monograph of its kind, and his later publications are all of importance. Lartet's various works are of permanent value, and his application of palæontology to archæology brought notable results. The volume of Alphonse Milne-Edwards on fossil crustacea was a fit supplement to Brongniart and Desmarest's well-known work, while his grand memoir on fossil birds deserves to rank with the classic volumes of Cuvier. Duvernoy, Filhol, Hébert, Sauvage, and others, have also published interesting results on fossil vertebrates.

Van Beneden's researches on the fossil vertebrates of Belgium have produced results of great value. Pictet, Rütimeyer, and Wedersheim in Switzerland, Bianconi, Forsyth-Major, and Sismonda in Italy, and Nodot in Spain, have likewise published important memoirs. The extinct vertebrates have been studied in Germany by von Meyer, Carus, Fraas, Giebel, Haeckel, Haase, Hensel, Kayser, Kner, Ludwig, Peters, Portis, Maack, Salenka, Zittel, and many others; in Denmark by Reinhardt; and in Russia by Brandt and Kowalevsky.

The fossil invertebrates have been investigated with care by D'Archiac, D'Orbigny, Bayle, Fromentel, Oustalet, and others in France; Desor, Loriol, and Roux in Switzerland; Cappellini, Massalongo, Michellotti, Meneghini, and Sismonda in Italy; Barrande, Benecke, Beyrich, Dames, Dorn, Ehlers, Geinitz, Giebel, Gümbel, Feistmantel, Hagen, von Hauer, von Heyden, von Fritsch, Laube, Oppel, Quenstedt, Roemer, Schlüter, Suess, Speyer, and Zittel in Germany, and Winkler in Holland. The fossil plants have been studied in these countries by Massalongo, Saporta, Zigno, Fiedler, Goldenberg, Gehler, Heer, Goeppert, Ludwig, Schimper, Schenk, and many others.

Among the recent researches in palæontology in other regions may be mentioned those of Blanford, Feistmantel, Lydekker, and Stoliczka; in India, Haast and Hector in New Zealand, and Krefft and McCoy in Australia; all of whom have published valuable results.

Of the progress of palæontology in America I have thus far said nothing, and I need now say but little, as many of you are doubtless familiar with its main features. During the first and second periods in the history of palæontology, as I have defined them, America, for most excellent reasons, took no part. In the present century, during the third period, appear the names of Bigsby, Green, Morton, Mitchell, Rafinesque, Say, and Troost, all of whom deserve mention. More recently, the researches of Conrad, Dana, Deane, De Kay, Emmons, Gibbes, Hitchcock, Holmes, Lea, Owen, Redfield, Rogers, Shumard, Swallow, and many others, have enlarged our knowledge of the fossils of this country.

The contributions of James Hall to the invertebrate palæontology of this country form the basis of our present knowledge of the subject. The extensive labours of Meek in the same department are likewise entitled to great credit, and will form an important chapter in the history of the science. The memoirs of Billings, Gabb, Scudder, White, and Whitfield are numerous and important, and the publications of Derby, Hartt, James, Miller, Shaler, Rathburn, and Winchell, are also of value. To Dawson, Lesquereux, and Newberry, we mainly owe our present knowledge of the fossil plants of this country.

The foundation of our vertebrate palæontology was laid by Leidy, whose contributions have enriched nearly every department of the subject. The numerous publications of Cope are well known. Agassiz, Allen, Baird, Dawson, Deane, De Kay, Emmons, Gibbes, Harlan, Hitchcock, Jefferson, Lea, Le Conte, Newberry, Redfield, St. John, Warren, Whitney, Worthen, Wyman, and others, have all added to our knowledge of American fossil vertebrates. The chief results in this department of our subject, I have already laid before you on a previous occasion, and hence need not dwell upon them here.

In this rapid sketch of the history of palæontology, I have

thought it best to speak of the earlier periods more in detail, as they are less generally known, and especially as they indicate the growth of the science, and the obstacles it had to surmount. With the present work in palæontology, moreover, you are all more or less familiar, as the results are now part of the current literature. To assign every important discovery to its author would have led me far beyond my present plan. I have only endeavoured to indicate the growth of the science by citing the more prominent works that mark its progress, or illustrate the prevailing opinions and state of knowledge at the time they were written.

In considering what has been accomplished, directly or indirectly, it is well to bear in mind that without palæontology there would have been no science of geology. The latter science originated from the study of fossils, and not the reverse, as generally supposed. Palæontology, therefore, is not a mere branch of geology, but the foundation on which that science mainly rests. This fact is a sufficient excuse, if one were wanting, for noting the early opinions in regard to the changes of the earth's surface, as these changes were first studied to explain the position of fossils. The investigation of the latter first led to theories of the earth's formation, and thus to geology. When speculation replaced observation, fossils were discarded, and for a time the mineral characters of strata were thought to be the key to their position and age. For some time after this, geologists, as we have seen, apologised for using fossils to determine formations, but for the last half century their value for this purpose has been fully recognised.

The services which palæontology has rendered to botany and zoology are less easy to estimate, but are very extensive. The classification of these sciences has been rendered much more complete by the intercalation of many intermediate forms. The probable origin of various living species has been indicated by the genealogies suggested by extinct types; while our knowledge of the geographical distribution of animals and plants at the present day has been greatly improved by the facts brought out in regard to the former distribution of life on the globe.

Among the vast number of new species which have been added are the representatives of a number of new orders entirely unknown among living forms. The distribution of these extinct orders, among the different classes, is interesting, as they are mainly confined to the higher groups. Among the fossil plants, no new orders have yet been found. There are none known among the protozoa or the mollusca. The radiates have been enriched by the extinct orders of Blastoidea, Cystidea, and Edrioasterida; and the crustaceans by the Eurypterida and Trilobita. Among the vertebrates no extinct order of fossil fishes has yet been found; but the amphibians have been enlarged by the important order labyrinthodonta. The greatest additions have been among the Reptiles, where the majority of the orders are extinct. Here we have at the present date the Ichthyosauria, Sauranodontia, Plesiosauria, and Mosasauria among the marine forms; the Pterosauria, including the Pteranodontia, containing the flying forms; and the Dinosauria, including the Sauropoda—the giants among reptiles; likewise the Dicynodontia and probably the Theriodontia, among the terrestrial forms. Although but few fossil birds have been found below the tertiary, we have already among the mesozoic forms three new orders: the Saururæ, represented by *Archæopteryx;* the Odontotormæ, with *Ichthyornis* as the type; and the Odontolcæ, based upon *Hesperornis;* all of these orders being included in the sub-class Odontornithes, or toothed birds. Among Mammals, the new groups regarded as orders are the Toxodontia, and the Dinocerata, among the Ungulates; and the Tillodontia, including strange eocene mammals whose exact affinities are yet to be determined.

Among the important results in vertebrate palæontology are the genealogies, made out with considerable probability, for various existing animals. Many of the larger mammals have been traced back through allied forms in a closely-connected series to early tertiary times. In several cases the series are so complete that there can be little doubt that the line of descent has been established. The evolution of the horse, for example, is to-day demonstrated by the specimens now known. The demonstration in one case stands for all. The evidence in favour of the genealogy of the horse now rests on the same foundation as the proof that any fossil bone once formed part of the skeleton of a living animal. A special creation of a single bone is as probable as the special creation of a single species. The method of the palæontologist in the investigation of the one is the method for the other. The only choice lies between natural derivation and supernatural creation.

For such reasons it is now regarded among the active workers in science as a waste of time to discuss the truth of evolution. The battle on this point has been fought and won.

The geographical distribution of animals and plants, as well as their migrations, have received much new light from palæontology. The fossils found in some natural divisions of the earth are related so closely to the forms now living there that a genetic connection between them can hardly be doubted. The extinct marsupials of Australia and the edentates of South America, are well-known examples. The pliocene hippopotami of Asia and the South of Europe point directly to migrations from Africa. Other similar examples are numerous. The fossil plants of the Arctic region prove the existence of a climate there far milder than at present, and recent researches at least render more probable the suggestion, made long ago by Buffon, in his "Epochs of Nature," that life began in the Polar regions, and by successive migrations from them the continents were peopled.

The great services which comparative anatomy rendered to palæontology at the hands of Cuvier, Agassiz, Owen, and others, have been amply repaid. The solution of some of the most difficult problems in anatomy has received scarcely less aid from the extinct forms discovered than from embryology, and the two lines of research supplement each other. Our present knowledge of the vertebrate skull, the limb-arches, and the limbs, has been much enlarged by researches in palæontology. On the other hand, the recent labours of Gegenbaur, Huxley, Parker, Balfour, and Thacher, will make clear many obscure points in ancient life.

One of the important results of recent palæontological research is the law of brain-growth, found to exist among extinct mammals, and to some extent in other vertebrates. According to this law, as I have briefly stated it elsewhere, "all tertiary mammals had small brains. There was, also, a gradual increase in the size of the brain during this period. This increase was confined mainly to the cerebral hemispheres, or higher portions of the brain. In some groups the convolutions of the brain have gradually become more complicated. In some the cerebellum and the olfactory lobes have even diminished in size." More recent researches render it probable that the same general law of brain-growth holds good for birds and reptiles from the mesozoic to the present time. The cretaceous birds, that have been investigated with reference to this point, had brains only about one-third as large in proportion as those nearest allied among living species. The dinosaurs from our Western Jurassic follow the same law, and had brain cavities vastly smaller than any existing reptiles. Many other facts point in the same direction, and indicate that the general law will hold good for all extinct vertebrates.

Palæontology has rendered great service to the more recent science of archæology. At the beginning of the present period a re-examination of the evidence in regard to the antiquity of the human race was going on, and important results were soon attained. Evidence in favour of the presence of man on the earth at a period far earlier than the accepted chronology of six thousand years would imply, had been gradually accumulating, but had been rejected from time to time by the highest authorities. In 1823 Cuvier, Brongniart, and Buckland, and later, Lyell, refused to admit that human relics, and the bones of extinct animals found with them, were of the same geological age, although experienced geologists, such as Boué and others, had been convinced by collecting them. Christol, Serres, and Tournal, in France, and Schmerling in Belgium, had found human remains in caves, associated closely with those of various extinct mammals, and other similar facts were on record.

Boucher de Perthes, in 1841, began to collect stone implements in the gravels of the valley of the Somme, and in 1847 published the first volume of his "Antiquités celtiques." In this work he described the specimens he had found and asserted their great antiquity. The facts as presented, however, were not generally accepted. Twelve years later Falconer, Evans, and Prestwich examined the same localities with care, became convinced, and the results were published in 1859 and 1860.

About the same time Gaudry, Hébert, and Desnoyers also explored the same valley, and announced that the stone implements there were as ancient as the mammoth and rhinoceros found with them. Explorations in the Swiss lakes and in the Danish shell heaps added new testimony bearing in the same direction. In 1863 appeared Lyell's work on the "Geological Evidences of the Antiquity of Man," in which facts were brought together from various parts of the world, proving beyond question the great age of the human race.

The additional proof since brought to light has been extensive, and is still rapidly increasing. The quaternary age of man is now generally accepted. Attempts have recently been made to approximate in years the time of man's first appearance on the earth. One high authority has estimated the antiquity of man merely to the last glacial epoch of Europe as 250,000 years, and those best qualified to judge would, I think, regard this as a fair estimate.

Important evidence has likewise been adduced of man's existence in the tertiary, both in Europe and America. The evidence to-day is in favour of the presence of man in the pliocene of this country. The proof offered on this point by Prof. J. D. Whitney, in his recent work,[1] is so strong, and his careful, conscientious method of investigation so well known, that his conclusions seem inevitable. Whether the pliocene strata he has explored so fully on the Pacific coast corresponds strictly with the deposits which bear this name in Europe, may be a question requiring further consideration. At present the known facts indicate that the American beds containing human remains, and works of man, are at least as old as the pliocene of Europe. The existence of man in the tertiary period seems now fairly established.

In looking back over the history of palæontology, much seems to have been accomplished, and yet the work has but just begun. A small fraction only of the earth's surface has been examined, and two large continents are waiting to be explored. The "imperfection of the geological record," so often cited by friends and foes, still remains, although much improved, but the future is full of promise. In filling out this record America, I believe, will do her full share, and thus aid in the solution of the great problems now before us.

I have endeavoured to define clearly the different periods in the history of palæontology. If I may venture, in conclusion, to characterise the present period in all departments of science, its main feature would be a *belief in universal laws*. The reign of Law, first recognised in the physical world, has now been extended to Life as well. In return, Life has given to inanimate nature the key to her profounder mysteries—Evolution, which embraces the universe.

What is to be the main characteristic of the next period? No one now can tell. But if we are permitted to continue in imagination the rapidly converging lines of research pursued to-day, they seem to meet at the point where organic and inorganic nature become one. That this point will yet be reached I cannot doubt.

THE EFFECT OF SUNLIGHT UPON HYDROGEN PEROXIDE[2]

WE believe that it has not been previously observed that hydrogen peroxide in solution is decomposed by sunlight; it may therefore be of interest to state that during the continuation of our investigations on the chemical effects of sunlight, we found that (1) after about ten months insolation aqueous solutions, containing about 8 per cent. of hydrogen peroxide, were entirely destroyed, and that (2) corresponding solutions shielded from light proved much more stable than is commonly supposed. We are inclined to think that the insolation needs to be prolonged—although we have made no direct observations on this point—because some of the solution, exposed in a thick glass bottle standing in a window, was found to be still of considerable strength after a period sufficient to destroy a corresponding sample in a thin test-tube.

We have elsewhere[3] shown that oxalic acid is destroyed by sunlight by the oxidation of its hydrogen by *external* oxygen, thus:—

$$C_2O_4H_2 + O - = 2CO_2 + H_2O.$$

[1] "Auriferous Gravels of the Sierra Nevada of California." 1879.

[2] By Arthur Downes, M.D., and T. P. Blunt, M.A.

[3] *Proc.* Roy. Soc., vol. xxviii. p. 204.

There is not, we believe, any analogy whatever between that case and this. There we have the "chlorous radicle" C_2O_4 in combination with the basylous H_2, the latter being seized upon by the superior affinity of the external oxygen stimulated under sunlight. Here we may regard the hydrogen peroxide as made up of two atomic groupings of the chlorous radicle HO and, if the theory we suggest be correct, the decomposition in this case is brought about by the dissociation of these radicles. We believe that the tendency of sunlight is to dissociate (or "weaken the internal bonds" between) what we have termed "chlorous radicles," whether these be simple, as oxygen or chlorine, or compound as HO, and thus to promote their combining energy, or to bring about a more stable arrangement of their constituent atoms.

THE FRENCH ASSOCIATION

AMONG the addresses at the Montpellier meeting we must notice that of Col. Laussedat, on geography considered from the point of view of protecting national independence, and on the creation of a French Signal Corps, in imitation of the well-known United States organisation.

M. Broca arrived just in time to give information relating to the Congress of Anthropology which had taken place in Moscow, and at which he had assisted with eleven other French *savants*. The expenses of the journey were paid by the Moscow Anthropological Society and by private donations. The session, the proceedings of which will appear in the *Journal des Missions du Ministère de l'Instruction publique*, and were reported in several French papers, lasted twelve days. M. Quatrefages was considered the head of the party, and gave in their name the loyal Russian toasts in the Kremlin. It is the first time that French *savants* have been entertained in this historical edifice, which was burnt to thwart the designs of the great French conqueror.

M. Chauveau, the Director of the Veterinary School of Lyons, was elected the President for the exceptional meeting at Algiers. The Secretary appointed for this occasion was M. Maunoir, the Permanent Secretary of the Geographical Society of Paris. This election shows that geographical questions will take a prominent place in April, 1881, at the capital of the French colony in North Africa. Much will be heard of the Transaharian, and it is expected that work will be begun on a large scale in the desert on this occasion. The nomination of M. Chauveau took place against the wish of the Council of the Society, who had presented as their candidate M. Baillon, the author of the Botanical Dictionary. The appointment of M. Chauveau is considered as a protest against the Haeckelian tendencies of the committee and a revival of the old Montpellier vitalist opinions. At all events, it has created some sensation.

The meeting for 1880 will take place in Rheims, as usual in the month of August, and is sure to be attended by a number of foreign visitors. Great preparations are being made by the local committee to give to the guests an unprecedented reception and to impress upon them a great idea of the peculiarities of the city.

SPECTROSCOPICAL OBSERVATIONS OF SHOOTING STARS

PROF. VON KONKOLY, of the Astro-physical Observatory of O-Gyalla (Hungary), contributes an interesting paper on the spectra of shooting stars to a recent number of the *Astronomische Nachrichten*, from which we note the following data:—On July 26 and 28, and again on August 12 and 13, the Professor had the opportunity of observing some bright shooting stars spectroscopically, and, with a few exceptions, he arrived at the result that the heads of shooting stars give a continuous spectrum generally, upon which very often the bright sodium line appears projected. Since this, however, is not always the case, Prof. von Konkoly inclines to the belief that considerable differences of elevation exist amongst shooting stars, and that those which do not show the sodium line are travelling in very much higher regions than those which do show the line in question, since he looks upon the sodium line as not belonging to the shooting star itself, but as resulting from the atmospheric air which the meteorite condenses and renders incandescent. It is evident that in very high regions there must be very much less (if any) chloride of sodium suspended in the atmosphere than in lower strata.